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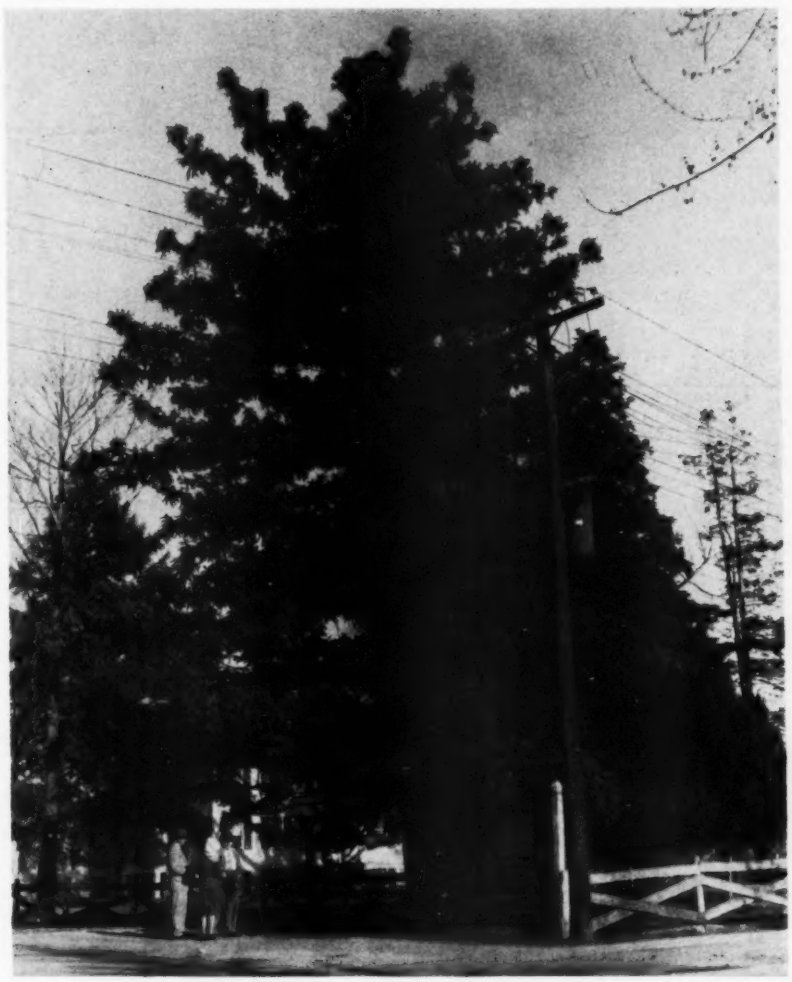

Fig 31. China-Fir (*Cunninghamia lanceolata* (Lamb.) Hook.)
Northerly tree at Bowling Green, Virginia.

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THE ASSOCIATES, through whose interest and generosity The *Bulletin* and certain other undertakings of the Arboretum are made possible, is an informal group of individuals interested in encouraging and furthering the educational and research endeavors of the Morris Arboretum. Further information concerning this organization will be sent on request.

China-Fir Trees at Bowling Green, Virginia

The purpose of this note is not to give a detailed account of this species of evergreen conifer native to China but rather to call attention to two superb old specimens in Bowling Green, Caroline County, Virginia.

Claims of the "largest" or "oldest" in almost any connection are hazardous; somewhere someone is likely to turn up with a "larger" or an "older." But if there be specimens of *Cunninghamia lanceolata* extant in the United States which in age, size, and beauty equal or surpass those in Bowling Green, it is hoped that those who have knowledge of them, either in the flesh or through published accounts, will challenge the writer's tentative claim. *The Morris Arboretum Bulletin* will be glad to publish such communications in subsequent issues, especially if accompanied by photographs, specimens, and accurate data (location, age, height, trunk dimensions, crown spread, etc.).

The species was discovered in China in 1702 by the botanical collector J. Cunningham, after whom the genus is named. Since then only one other species of the genus has been found—*Cunninghamia Konishii* from Taiwan (Formosa). *Cunninghamia lanceolata* is widely distributed in mountain valleys of central and southern China where under forest conditions it forms magnificent trees up to 120 feet in height and 18 feet in girth, with straight mast-like trunks clear of branches for half the height of the trees. The wood is light, soft, fragrant, easily worked, durable, and, according to E. H. Wilson ("A Naturalist in Western China"), the most generally useful timber, next to bamboo, in China. The bark is durable and often used for roofing houses.

The species was introduced into England (Kew Gardens) in 1804 by direction of the East India Company. In the warmer part of Britain it thrives. But even at Kew all specimens were killed down to the ground in the hard winter of 1894-95. (The species from Formosa is even more tender.) It is not surprising therefore that in the general Philadelphia region the Chinese species can at best be said to persist, so subject is it to recurring winter injury.

Southward it fares better. In Virginia and North Carolina the writer has encountered it occasionally in gardens where to all appearances it is hardy. However, the trees are, so far as observed, all relatively young. The greater the surprise, therefore, to find the two venerable monarchs in Bowling Green, compared with which all others seen are mere youngsters.

The trees are at the home of Mr. Roper Rains

Fig. 32. China-Fir. Southerly tree in winter condition at Bowling Green, Virginia.

Fig. 33. China-Fir. Southerly tree at Bowling Green, Virginia, showing dense appearance toward completion of Spring growth.

fronting on U. S. Route #301 at the southerly edge of Bowling Green, which lies about 40 miles due north of Richmond and almost exactly at latitude 38 degrees. Noting the trees in February, 1948, the writer's colleague Dr. E. T. Wherry a month later likewise inspected them, bringing them to the attention also of Dr. Hugo Iltis of Mary Washington College in Fredericksburg. Apprised by Dr. Iltis of the unique botanical feature nearby, the Fredericksburg *Free Lance-Star* published an illustrated article on the trees in its issue of May 8, 1948. The writer is indebted to this newspaper and to its photographer, Mr. James McKnight, for kind permission to use two of the photographs here reproduced (Figs. 31 and 32), one of which (Fig. 32) appeared in the *Free Lance-Star* article.

Mr. Rains informed the writer that the trees were planted by his grandfather, who obtained them from a Long Island, New York, nursery. Their exact age is not known but Mr. Rains is of the opinion that they are over 100 years old. They are part of a definite planting pattern in which are extant also two large Nordmann firs *(Abies Nordmanniana)*, and two old eastern hemlocks *(Tsuga canadensis)*, presumably all planted about the same time. One of the Nordmann firs is definitely declining; the other is in tolerable condition, measuring (in March, 1948) 78 feet in height and 34.7 inches in diameter at breast height. On the tenable assumption that the Nordmann firs are strictly contemporaries of the China-firs, the age of the latter might be arrived at indirectly but fairly accurately by counting the annual rings on the core of an increment boring in the declining Nordmann fir.

The two Cunninghamias are both in excellent condition. Because of their uniqueness, photographs of both are here reproduced. On the more northerly one (Fig. 31), being closer to the street, some of the side branches have been cut back because of wires, poles, and sidewalk. The southerly one (Fig. 32), standing somewhat farther from the street, has escaped mutilation except some natural curtailment of side branches on two sides by shading from neighboring trees. The following measurements were taken in March, 1948:

Northerly tree: Height, 64 feet; crown spread, 54 feet; diameter of single trunk below level of division into three stems, 39.5 inches; diameters of the three stems, 14.9, 18.0, and 22.5 inches.

Southerly tree: Height, 60 feet; crown spread, 67 feet; trunk diameter 3 feet above ground, 41.5 inches.

The Bowling Green trees shed small branches in large numbers, forming a thick litter under the trees (see Fig. 32), the shed branchlets still clothed with the now browned, stiff and sharply pointed leaves. As a result the crowns by the end of winter are somewhat less dense. But with the onset of spring growth they thicken, the trees taking on increasingly a beautiful rich dense woolly aspect to which our photograph (Fig. 33) does not begin to do justice. Mention should be made also of the fact that in the spring of 1948 the trees bore incredible numbers of staminate cones characteristically clustered at the ends of the branchlets.

No account of these trees can adequately portray Bowling Green's unique botanical treasure. Surely not the least of the distinctions of this charming community is that it is the enviable possessor and custodian of what are believed to be the largest and finest specimens of this noble species in the United States.

J. R. SCHRAMM

Notes From the Laboratory

SELENIUM AND THE INSECT PESTS OF BOXWOOD

The Pest Problem.—Boxwood growing in the Philadelphia region is troubled from time to time by at least three insect pests: leaf miner, mite and psylla. Boxwood leaf miner, one of the worst of these pests, is likely to be particularly injurious to the Japanese Box, *Buxus microphylla japonica,* and the taller-growing forms of the Tree (or so-called "American") Box, *Buxus sempervirens.* It is seldom serious on the English Box, *Buxus sempervirens suffruticosa.* The latter plant is, however, attacked in most seasons by the boxwood mite, a pin-point sized creature akin to red spider which infests the leaves in great numbers, and in their sucking produce a yellowish mottling of unhealthy appearance. Other forms of boxwood are infested with this insect but seldom so seriously. The third familiar pest is the small psylla or grayish, waxy-covered aphid which sucks the centers of the young leaves early in the growing season and causes them to assume a curiously cupped and deformed appearance. It attacks all varieties.

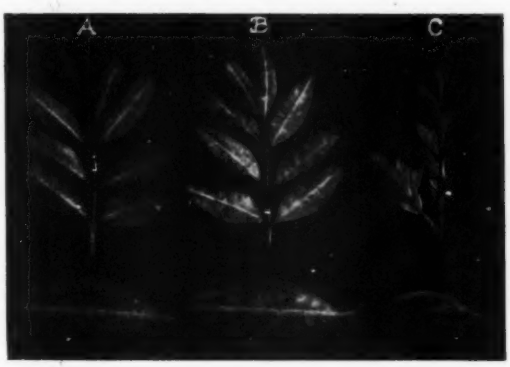

Fig. 34. The evidence of insect attack. A—Healthy foliage. B—Swellings on undersides of the leaves caused by leaf-miner. C—Mottling of the upper leaf surface caused by mites.

Until comparatively recently it had usually been found that if these three insects could be reasonably well controlled no further problems were especially serious, but of late years the picture has changed. English boxwood in particular has seemed overly susceptible to some of these pests but in addition individual bushes have all too often become scrappy and misshapen through the loss of whole branches which die quite suddenly as a result perhaps of winter injury or fungus attack. We now realize that these several symptoms are most probably due to a serious weakening of the plant by an additional and very insidious pest. This pest is an eelworm or nematode which feeds *within* the roots, killing them in large numbers and thus completely weakening the plant from the bottom up. Such a weakened plant becomes an immediate prey to drought, to winter injury or to insect or fungus attack. Nematodes are microscopic in size, they persist for some time in the soil in the absence of the plant host, and while they can be killed quite readily by methods of soil sterilization, up to the present no method of control has been found effective for killing them within the roots of infested boxwoods. The chemicals which kill them in the soil are usually fatal to the plant roots.

Selenium — The Boxwood collection at the Arboretum suffered a severe attack of leaf miner in 1945, and since the old nicotine and molasses spray gave at best rather mediocre results (little was then known of DDT in this connection), it was decided to test the possibilities of the poison, selenium, which Dr. W. E. Blauvelt was already using with marked success at Cornell University for control of the insect pests of greenhouse-grown chrysanthemums. Selenium is a poisonous element occurring naturally in local areas in the prairie states where it is absorbed by certain plants and is known to be fatally poisonous to cattle or human beings feeding upon such plants. As an insecticide, it is applied to the soil in which the plant grows; it is absorbed by the roots and acts as a stomach poison to insects subsequently feeding upon any part of the plant. Because it is so poisonous, and because in soil application it may be accumulated by many types of plants—fruits and vegetables as well as ornamentals — its use, even for experimental purposes, calls for the utmost caution at all times.

The first tests of selenium as a control for Boxwood Leaf Miner were made upon two species of greenhouse-grown boxwoods in the winter of 1945-46. Results were encouraging, and the following notes will describe the effect of these and numerous subsequent selenium applications upon the pest population and general vigor of outdoor-grown boxwoods in several species and varieties.

Methods of Application—Selenium was used in these tests in the form of the readily water-soluble sodium selenate, and the dissolved selenate was watered into the soil in amounts varying from ¼ gm to 3 gms per square foot dissolved in

sufficient water to thoroughly moisten the ground throughout the expected region of root penetration. As a general rule it was arbitrarily assumed that a desirable amount of water for this purpose is about 30 gallons per 100 square feet of soil surface. Small areas were thus treated by placing a given weight of the salt in the necessary volume of water and applying the solution with a sprinkling can. On larger areas the Hozon proportioner was found useful with the garden hose, although the advertised 10-1 delivery of the proportioner was found to be rather unreliably variable with differences of water pressure. During the present season a more convenient method of application has been used which seems quite satisfactory: the ground about the plants is first soaked very thoroughly with the hose and the necessary amount of selenium is dissolved in about 2 gallons of water and applied as evenly as possible with a fine sprinkler. Penetration of this more concentrated salt solution would probably be equally effective after a heavy rain provided one is certain that the ground has been evenly and completely moistened.

Evaluation of Results — Evaluations of the effectiveness of treatment upon control of the leaf-feeding insects have been arrived at by examination of approximately 50 leaves, random selection, per treated or check plant. In the case of leaf miner the number of ovipositions per leaf can be readily counted shortly after occurrence, and the number of such ovipositions resulting in new larvae can also be accurately determined within a few weeks. In the case of boxwood mite it has seemed sufficient to record this pest on a basis of presence or absence per leaf only.

In recording shoot elongation as being possibly influenced by the treatments, average lengths were taken of 50 current-season shoots per treated and check plants representing a distribution of 15 terminal shoots, 25 side shoots from these terminals and ten side shoots from lower down on each bush. Although not accurate, such a figure is felt to be reasonably indicative for a given plant. Root nematode populations could be determined on a comparative basis only. While microscopic examination yields valuable information regarding the nematode activity level in a given sample, the effects of general infestation of the root mass is usually so easy to recognize that with representative root portions the extent of infestation can be comparatively estimated by simple observation.

THE CONTROL OF LEAF MINER

The first intended use of selenium at the Morris Arboretum was as a possible agent for control of the Boxwood Leaf Miner, *Monarthropalpus buxi.*

The Insect — The adult leaf miner is an orange-bodied fly about 1/10th of an inch long, which in bad infestations emerges in swarms from the lower side of the older leaves in late May or early June. Over a period of about a week the female flies deposit their eggs inside the leaves of newly developing shoots. Held against the light, each oviposition can be identified as a pale pinpoint spot. Within a few weeks newly-hatched larvae (the "miners") commence feeding inside the leaf. This feeding continues until cold weather in fall and recommences in spring. When full development is reached in April or early May the larvae pupate for a brief period to emerge as the new crop of adult flies. The mature larvae may be so voracious in their feeding that on a warm, quiet day in April an infested bush may audibly crackle with their activity.

Treatments and Results—During the winter of 1945-46 eight 18-inch nursery-grown plants of *Buxus sempervirens arborescens,* eight of *B. semp. angustifolia* and four 3-foot specimens of *B. microphylla japonica* were divided among four soil plots of 12 square feet each in a greenhouse bench. The leaves of all plants were already heavily infested with developing leaf miners. On March 11, 1946, Plot #1 received 2 grams of sodium selenate, plot #2 received 4 grams, plot #3, 6 grams, plot #4 no treatment. Development of the miner larvae was in no way affected. They pupated normally and emerged as flies in early May. Indiscriminate oviposition followed in the young leaves of all the plants. On August 29th a careful check was taken of the miner situation, since by this time the young larvae would normally be in a sizeable and active condition. The results were as follows: Through all varieties an average of 74% of the counted leaves showed oviposition scars, in some cases as many as 23 to a leaf. In general the numbers were highest in *B. microphylla japonica* and lowest in *B. semp. arborescens.* On a plot basis oviposition bore no particular relation to treatment. Plots #1 and #3 had the highest rate (80 and 81%) and the check plot #4 the lowest (64%). There had been abundant ovipositions, but the count of the number of these ovipositions which had developed into maturing larvae was especially revealing. In untreated plot #4, 29% (a little low in comparison with later findings) of the egg depositions had produced actively feeding larvae, while no larvae of any kind were found on the treated plots. If they had emerged from the egg stage they had evidently died with their first feeding.

A similar experiment was run concurrently on 2- to 3-foot plants of *B. sempervirens rotundifolia, B. semp. angustifolia* and *B. microphylla japonica* growing in a cultivated nursery. On April 11, 1946, the ground about four plants of

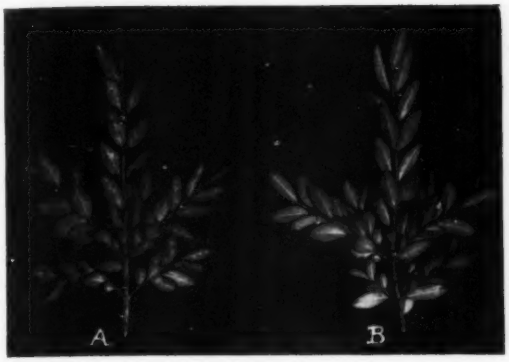

Fig. 35. The control of leaf-miner with selenium. A—Miner infested shoot from untreated plant of *Buxus semp. arborescens.* B—Healthy shoot from similar plant of the same species treated with sodium selenate in early April. Photographed in September.

each variety was treated with sodium selenate at the rate of 1 gram per square foot of branch spread. Four plants of each variety were left untreated. As before, the plants were heavily infested with leaf miners which matured and oviposited normally—(28 times on some leaves of treated plants). Allowing time for development of the new miners, examination was made for their presence on the following August 27th when it was found that while an average of 58% of ovipositions on leaves of check plants produced actively feeding larvae, no larvae at all could be found where the selenate had been used.

General Observations—Since these two tests were carried out, selenium applications have been made to numerous boxwood varieties in nursery rows and permanent plantings with usually very satisfactory results from the standpoint of leaf miner control. Where control has not been completely effective the first season, it is likely to be traceable to one of three reasons: (1) the selenate concentration may have been too low—the effective minimum seems to be about ½ gram per square foot; (2) application was made too late—it should preferably be done in spring *before* growth takes place; or (3) the amount of selenium solution was insufficient for contact with the spreading root system of an old established specimen. It is interesting to note that a late application made when shoot growth was half developed may not result in killing the larvae until late fall, but it is eventually effective. Furthermore, the nursery plants treated in 1946 showed complete control of leaf miner for two seasons. This year very light infestation is visible for the first time.

Conclusions—So far as this particular pest is concerned, selenium gives very fair promise as an effective control in the event that alternatives to present insecticides such as DDT are sought. It is perhaps one of the first instances where selenium has been satisfactorily used with a typically woody plant.

BOXWOOD MITE

While common red spider frequently attacks boxwood along with a host of other plants, the brown colored slightly smaller and more specialized boxwood mite, *Paratetranychus yothersii* seems to do most of the damage at the Arboretum. In normal seasons it is particularly prevalent on the English Box in late summer (see Fig 34) but also attacks other species and varieties with the possible exception of those forms of *B. sempervirens* with deep green, leathery leaves such as *Handsworthii, aureo-variegata, bullata,* etc. Such forms are, in fact, usually the last to be bothered by leaf insects of any kind.

Treatments and Results—It was observed during the course of the succeeding summer that the selenium treatments of March 11 and April 11, 1946, were having a distinct effect not only upon the leaf miners but also upon the color of the upper leaf surfaces. No yellowish mottling was in evidence. Careful examination was consequently made on September 10, 1946, for signs of mite infestation. Among untreated plants growing under nursery conditions, 7% of the leaves of *B. semp. rotundifolia,* 3% of the leaves of *B. semp. augustifolia* and 24% of the leaves of *B. microphylla japonica* showed mite infestation. No evidence of such infestation, past or present, was discovered upon any treated plants of the same varieties. In 1948 these same treated plants show practically no indication of mite attack. More recent evidence indicates that Boxwood mites can be controlled on all varieties during a given season provided, as for leaf miner, that the selenium is applied in spring just before growth commences. Applications made at any time later are relatively ineffective the same season, especially with *B. semp. suffruticosa.* They do, however, tend to reduce the amount of infestation during the season following.

English Box—Throughout these tests it has been repeatedly observed that the English Box does not, unfortunately, give such a clear cut response to selenium treatments as do other varieties when the conditions of application are relatively ideal. Mites, for instance, may be controlled completely on some individuals, poorly on others. The reason for this may possibly be that selenium is most effectively absorbed when it is applied just before a period of vigorous shoot elongation. With dwarf-growing *B. semp. suffruticosa* shoot growth is never typically vig-

orous, and it is made over a rather protracted period. Unless it can be utilized promptly, it is likely that much of the selenium is leached from the soil before enough is absorbed to become effective.

BOXWOOD PSYLLA

The small sucking psyllid or aphid, *Psylla buxi,* causes its typical leaf cupping on most varieties of boxwood at the Arboretum. It is particularly partial to the Tree and Japanese Boxes and seems most serious on the soft growth made in semi shade, but in heavy infestations it is quite general. This pest is readily controlled by a contact insecticide such as nicotine sulphate, but it is of interest to note that any selenium treatment which is effective for leaf miner or mite gives good control at the same time of boxwood psylla. See Figure 38. From general observations it appears that this insect is perhaps easier to control by this means than boxwood mite. Late treatments, which have been only partially effective on the latter, have on occasion still eliminated the psylla quite completely.

do most damage to boxwoods at the Arboretum has been identified by Dr. G. Steiner, Division of Nematology of the U. S. Department of Agriculture, as the Meadow Nematode, *Pratylenchus* sp. From samples submitted for examination, Dr. Steiner was able to recognize three distinct species of Pratylenchus in roots of English Box and two specimens of Japanese Box growing at the Arboretum.

Varietal Susceptibility—From general observation, all forms of boxwood are susceptible to nematode attack. There are indications that the severity of infestation may be related to some extent to growing conditions, certainly to varietal influences. Plants seem less affected in hot dry positions, particularly in the proximity of sod. The coarse-leaved varieties of *Buxus sempervirens* seem least subject to attack, while *B. microphylla japonica* is quite susceptible, and *B. semp. suffruticosa,* the English Box, very susceptible indeed. As mentioned earlier, there is now little doubt that the severe root injury caused by nematodes is responsible for the ill health of many plants of English Boxwood in the Phila-

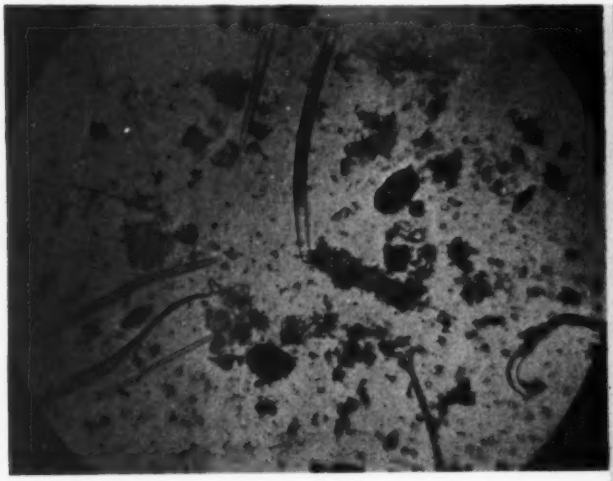

Fig. 36. Meadow nematodes from the roots of *Buxus sempervirens suffruticosa.* Magnified 40 times.

Fig. 37. Nematode-infested roots of English boxwood. The "Witches broom" effect results from continuous killing of the young rootlets.

SELENIUM AND NEMATODES

The Meadow Nematode—As has been previously pointed out, the attacking of boxwood plants by root nematodes presents the plantsman with a very serious problem. We have here a microscopic eelworm which feeds, produces eggs and its new generations within the young boxwood roots, and when these roots have died and decayed, persists in the soil about the boxwood plants to attack new roots or those of other types of plants in the vicinity. This pest exists in numerous species but the one which seems to

delphia district. Such injury not only impoverishes the plant through restriction of water and food supplies but in so doing renders it a ready prey to pest and disease attack, to winter injury, summer drought and any other adverse conditions.

General Controls—Nematodes enter the roots of newly set boxwoods (and other plants which are similarly attacked) from the soil. The first step toward preventing such trouble would be

to thoroughly sterilize the soil before planting, and for this purpose such chemicals as DD mixture, or methyl bromide, properly applied, are quite effective. Such treatments are already standard practice for many crops including roses, particularly in the southern states. Both these chemicals, however, must be used well before planting for they are toxic to living tissues. Unfortunately, no effective treatment is at present known for established boxwoods which have become subject to attack. However, the problem is now under active investigation at more than one experiment station so that it is to be hoped a workable solution may soon be forthcoming.*

The Use of Selenium—The seriousness of the nematode problem at the Arboretum became fully recognized two years ago. The double rows of English boxwood flanking the main path through the rose garden have been deteriorating for some time, and other specimen plants which had lost their vigor did not respond to feeding and improved cultural conditions as expected. Certain of them, however, have shown improvement in a rather remarkable way following the use of selenium primarily as a control for leafminer and the apparent relationship of this fact to the problem of root nematodes provides reason for the present discussion.

Reference has been made to a selenium treatment of 1 gram per square foot to nursery-grown plants of *Buxus sempervirens rotundifolia* on April 11, 1946. This application effectively controlled leaf miners and mites on the treated plants. One year later, in April 1947, additional pairs of plants of the same variety variously received applications of ¼, ½ and 1 gram sodium selenate per square foot. Pairs of untreated individuals separated each treatment within the row. It has been noted that the weak treatment of selenium did not give complete control of leaf miner, but in spite of this, all treatments had an evidently beneficial effect so far as growth and coloration of the plants were concerned. The foliage became a glossy dark green and the general appearance was that of an excellent response to fertilization—something which could not be accounted for on a basis of mere control of leaf-feeding insects. Untreated plants did not show this response. They remained in a relatively weak condition and during the past cold winter were injured so severely that three of these checks were killed outright and the remainder are still in very sorry condition. All selenium-treated plants survived the 1947-48 winter practically unscathed. A possible clue to this behavior is found by examination of the root system. In July of this year roots of the check plants, when not completely dead, were very heavily infested with nematodes. Practically no uninfested white feeding roots could be found. The roots of all selenium-treated plants, on the other hand, were for the most part straight growing, healthy and vigorous. They were not entirely free of nematodes, but infestation was not of serious proportions and the number of killed rootlets was relatively small. There was every appearance that selenium had been effective in controlling the nematode population and in so doing had restored to these particular plants their normal vigor and their normal winter hardiness.

Figure 38 illustrates another instance of the same effect, in this case with *Buxus microphylla japonica*. Shown in this figure are two established plants of this variety which in 1946 were entirely similar in appearance. Neither was making very good growth and both were badly infested by both leaf miner and boxwood psylla. One of them was treated with 1 gram of sodium selenate per square foot in April 1947. In July of the present year the untreated plant had made poor shoot growth; psylla and leaf miner were abundant and the roots were bunched and partially killed by nematodes (Fig. 38-4). The treated plant was entirely free from leaf miner although it had been very sparingly attacked by psylla. Growth was good, however, and the foliage a fine glossy dark green; feeding roots were long, straight and apparently healthy. Again, they were not entirely free of nematodes but the number present was evidently not sufficient to cause much damage. It would again appear that improvement of the plant had probably resulted from the effect of selenium in markedly reducing the nematode population. Similar observations have been made upon established plants of *Buxus semp. angustifolia,* additional specimens of *B. semp. rotundifolia* and *B. semp. microphylla.*

These results, unfortunately, have not been duplicated with the English box, for it is in this variety that nematodes constitute by far the most serious problem. These tests are continuing, however, and during the present season sodium selenate in a wider range of concentrations has been applied to 166 plants of which the majority are *B. semp. suffruticosa.* In the light of the indications of this progress report, it may well be that either concentration, method, or time of selenium application may be the present unknown factors in improved results, especially with the English boxwood.

* A fellowship has been established by the Bartlett Tree Expert Co. for investigation of this problem at the University of Maryland. The holder of this fellowship, Mr. A. C. Tarjan, is working under the able direction of Dr. Steiner, nematologist of the U. S. Department of Agriculture.

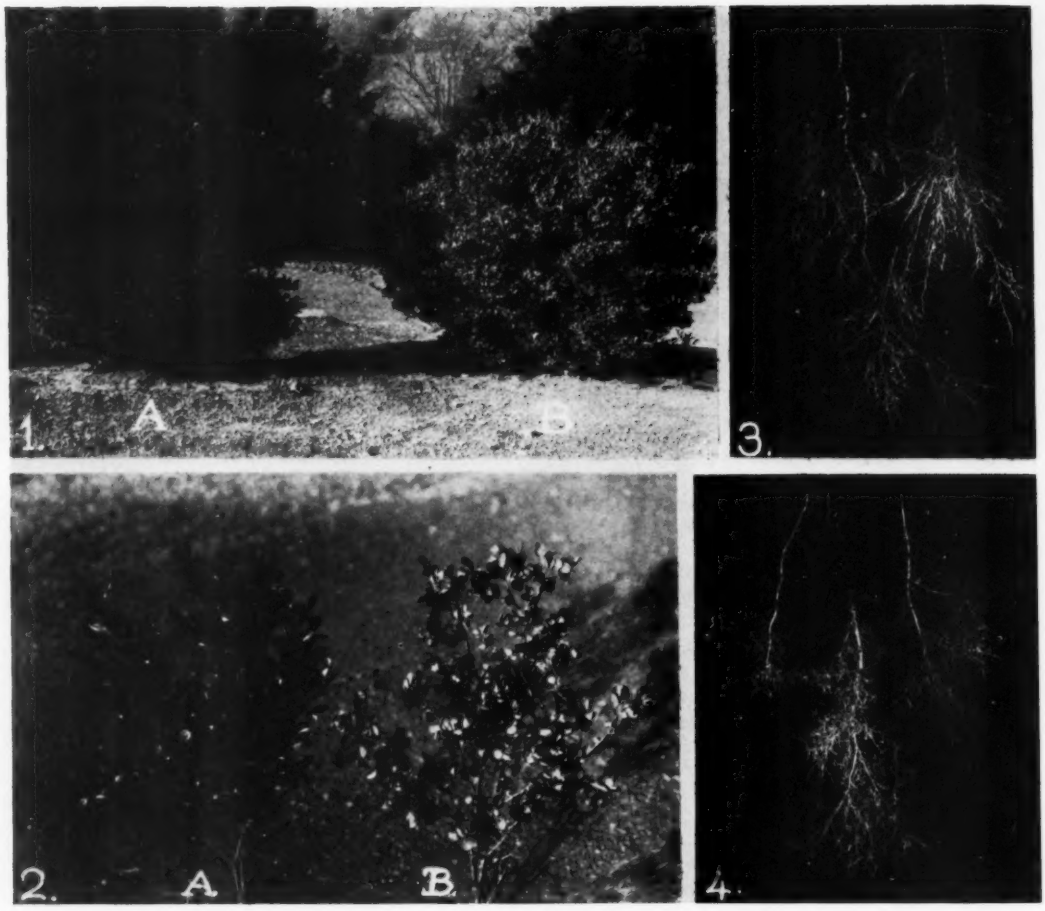

Fig. 38. Effect of selenium upon pest resistance and growth of *Buxus microphylla japonica*. 1A—Vigorous and dark-foliaged plant after spring treatment with sodium selenate. 1B—The untreated plant has sparse foliage of poor color. 2A—Shoot specimens from the treated plant. 2B—Specimen from the control plant; leaves are infested with both psylla and miner. 3—Sample roots from the treated plant (1A) are long, vigorous and comparatively free of nematodes. 4—Roots of the control plant remain typical of heavy nematode infestation.

GROWTH EFFECTS

It is well known that selenium salts may at times have a stunting effect upon plant growth when they are used in concentrations higher than may normally be needed for adequate control of insect pests. In still higher concentrations they may be lethal to the plant tissues. In view of these facts, it may be of interest to record a few observations regarding the responses of boxwood to selenium independently of the pest control relationship.

Three grams per square foot is the highest concentration of sodium selenate which has been used in these tests. At this strength no deleterious effects have been noted upon healthy roots of strong growing varieties of *Buxus sempervirens* or *Buxus microphylla*. However, a concentration of even two grams per square foot resulted in distinct injury to nematode-infested roots of *Buxus semp. suffruticosa*.

So far as vegetative growth is concerned, it has been noted that such may be increased when the limiting factor appears to be insect attack. However, growth measurements of fifty shoots each of three untreated plants of *B. microphylla japonica* and three plants treated early the same season with one gram per square foot of sodium selenate (all plants being in a quite healthy condition at the start), yielded the following data:

individual untreated plants averaged variously 5.23, 4.35, and 5.55 inches growth per shoot while those receiving selenium averaged 3.02, 3.45, and 3.22 inches. In other words, the shoots of untreated plants in this particular test made an average increased growth of 1.8 inches. Unfortunately enough completely healthy plants have not been available to secure more information on this point but it would appear that a concentration of even 1 gram per square foot may at times have a slightly stunting effect upon growth. It is improbable, however, that such an effect will carry into a second season and when pest control is the primary objective, and adequately secured, a secondary stunting of this nature is more than offset by the benefits resulting from pest reduction or eradication.

SUMMARY

In this progress report concerning the use of sodium selenate as a control for the pests of boxwood growing at the Morris Arboretum the following principal points have been noted:

1. Water solutions of sodium selenate at a concentration of one gram per square foot of root area are effective in controlling attacks of leaf miner, mite and psylla upon most species and varieties of boxwoods tested.

2. Such an application should be made immediately before growth commences in spring.

3. The useful range of selenate concentration appears to be somewhere between ¼ and 2 grams per square foot. At ¼ gram partial insect control was effected; at 2 grams root injury was observed.

4. Applications of 1 gram per square foot can apparently be effective in so reducing the root nematode populations of weakly growing established plants of certain varieties that normal health, vigor and a pest-resistant condition is almost entirely restored within one year.

5. The English Box, *Buxus sempervirens suffruticosa,* remains an outstanding exception in that sodium selenate cannot so far be considered a satisfactory control agent for either leaf-feeding insects or nematodes.

6. Selenium may have a slight stunting effect upon growth of normally vigorous boxwood plants during the first season following application. Such plants do not, however, appear to be otherwise injured and the effect is adequately offset when pest control is the major consideration.

The above results yield definite indications that selenium salts may find a place in the control of insect pests in certain woody, as well as herbaceous plants. It is to be emphasized that they do not, as yet, provide the solution to the current serious problem of the control of nematodes in the English Boxwoods. Further studies are needed. In view of these facts and in view of the earlier warning that selenium is a poisonous material requiring the utmost care in usage, it is to be emphasized that the indiscriminate use of sodium selenate by home gardeners is at present neither justified nor recommended.

HENRY T. SKINNER

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Additions to Arboretum Library

The most valuable gift that the Library has received for many years was a collection of 100 or more books, periodicals and pamphlets from the library of Mr. Frank M. Bartram of Kennett Square, descendent of John Bartram. This collection is almost entirely in the field of landscape architecture in which the Morris Arboretum library has been lamentably deficient. Outstanding among the titles included are the following:

AMERICAN GARDENS—Guy Lowell (Bates-Muda, 1902)

AMERICAN LANDSCAPE ARCHITECTURE, 1930-31

ARCHITECTURE AND DESIGN, Vol. III—Olmsted Bros. (1939)

BEAUTIFUL GARDENS IN AMERICA—Louise Shelton (Putnam, 1916)

BOOK OF OLD WORLD GARDENS, edited by A. H. Hyatt (LeRoy Phillips, 1912)

CENTRAL PARK, HISTORY AND DESIGN, edited by F. L. Olmsted, Jr. (Putnam, 1928)

CHARLES ELIOT, LANDSCAPE ARCHITECT—Charles W. Eliot (Houghton Mifflin, 1903)

DESIGN IN THE LITTLE GARDEN—Fletcher Steele (Atlantic Monthly, 1924)

RURAL ESSAYS—A. J. Downing (New York, 1858)

FAMOUS GARDENS—(Country Life Corporation, 1937)

FORTY YEARS OF LANDSCAPE ARCHITECTURE—F. R. Olmsted (Putnam, 1922)

GARDEN MAKING—E. Rehmann (Houghton Mifflin, 1926)

INTRODUCTION TO A STUDY OF LANDSCAPE DESIGN—Hubbard and Kimball (Macmillan, 1917)

JAPANESE GARDENS—Mrs. B. Taylor (Dodd, Mead, 1912)

LANDSCAPE ARCHITECTURE, 1922-1947

LANDSCAPE GARDENING—Beatrice Parsons (Putnam, 1895)

LANDSCAPE GARDENING—F. A. Waugh (Orange Judd, 1912)

THE NURSERY BOOK—L. H. Bailey (Rural Publishing Co., 1894)

OLD GARDENS IN AND ABOUT PHILADELPHIA—J. T. Faris (Bobbs Merrill, 1932)

OLD TIME GARDENS—A. M. Earle (Macmillan, 1906)

FREDERICK LAW OLMSTED, LANDSCAPE ARCHITECT—F. L. Olmsted, Jr. (New York, 1922)

PLANNING YOUR GARDEN—W. S. Rogers (Doubleday, 1923)

PRACTICAL BOOK OF GARDEN ARCHITECTURE—P. W. Humphreys (Lippincott, 1924)

PRACTICAL BOOK OF OUTDOOR FLOWERS—Richardson Wright (Lippincott, 1924)

REPTON ON LANDSCAPE GARDENING—J. C. Loudon (Longmans, 1840)

SIMPLE GUIDE TO ROCK GARDENING—J. L. Cotter (Sheldon Press, 1926)

THEORY AND PRACTICE OF LANDSCAPE GARDENING—A. J. Downing (Moore & Co., 1859)

E. H. WILSON, PLANT HUNTER—E. I. Farrington (Boston, 1931)

GENERAL ACQUISITIONS

The Arboretum Library has acquired by purchase or by gift within the past two years several useful books and pamphlets including the following titles:

AMERICA'S GARDEN BOOK—Louise and Carter Bush-Brown (Scribner's, 1947)

AMERICAN CONSERVATION IN PICTURE AND IN STORY—Ovid Butler (American Forestry Association, 1941)

AMERICAN TREES—Russell T. Limbach, (Random House, 1947)

BUILDING ESTIMATOR'S REFERENCE BOOK—Frank R. Walker (Walker Co., 1947)

CHECKLIST OF VASCULAR PLANTS OF MAINE—Dr. Fay Hyland (University of Maine, 1948)

CLEMATIS, LARGE AND SMALL-FLOWERED—E. Markham (London, 1935)

CLIMBERS AND GOUND COVERS—A. T. Hottes (DeLaMare, 1945)

CONIFERS IN CULTIVATION—Conference Proceedings of Royal Horticultural Society (London, 1932)

DANISH SPECIES OF ALTERNARIA AND STEMPHYLIUM, TAXONOMY, PARASITISM—Paul Neergaard (Copenhagen, 1945)

DECIDUOUS ORCHARDS—W. H. Chandler (Lee and Febiger, 1942)

DICTIONARY OF PRINCIPAL BOTANICAL AND HORTICULTURAL TERMS—A. M. C. J. Coninck (Stechert, 1926)

GARDENING WITH SHRUBS—Mary D. Lamson (Barrows & Co., 1946)

HANDBOOK OF RHODODENDRONS—(Univ. of Washington Arboretum Foundation, 1946)

HANDBOOK OF TREES OF THE NORTHERN STATES AND CANADA—R. B. Hough (Macmillan, 1947)

HORMONES AND HORTICULTURE—George S. Avery, Jr. (Magraw Hill, 1947)

HORTICULTURAL COLOUR CHART—British Colour Council in collaboration with Royal Horticultural Society (London, 1938)

LIST OF PLANT TYPES FOR LANDSCAPE PLANTING—S. F. Hamblin (Harvard Univ. Press, 1946)

NORTH AMERICAN TREES—R. J. Preston (Iowa State College Press, 1948)

PLANT HUNTERS IN THE ANDES—T. Harper Goodspeed (Farrar & Rinehart, 1941)

PLANT HUNTING IN CHINA—E. H. M. Cox (Collins, 1945)

PLANTING DESIGN—Florence Bell Robinson (Whittlesey House Garden Series, 1947)

PROPAGATION OF HORTICULTURAL PLANTS—Adriance and Bryson (McGraw Hill, 1939)

PROPAGATION OF PLANTS—C. A. Hottes (De La Mare Co., 1945)

REVIEW OF JUNIPERUS CHINENSIS ET AL—P. J. Van Melle (N. Y. Bot. Garden, 1942)

RHODODENDRON YEAR BOOK FOR 1946, 1947—(Royal Horticultural Society, 1946, 1947)

RHODODENDRON YEARBOOKS FOR 1945, 1946, 1947—(American Rhododendron Society, 1945, 1946, 1947

SOURCE-BOOK OF BIOLOGICAL NAMES AND TERMS—E. C. Jaeger and J. Q. Burch (Thomas, 1947)

TREES OF THE EASTERN UNITED STATES AND CANADA, THEIR WOODCRAFT AND WILDLIFE USES—W. M. Harlow (Magraw Hill Co., 1942)

THE HARDY HEATHS—A. T. Johnson (Gardeners Chronicle Ltd., 1928)

WILD FLOWER GUIDE, NORTHEASTERN AND MIDLAND UNITED STATES—E. T. Wherry (Doubleday, 1948)

WOMAN'S HOME COMPANION GARDEN BOOK, edited by John C. Wister (Doubleday, 1947)

M. CODE